PRECIOUS MANGROVE:

AN ETHNOGRAPHY OF ENVIRONMENTAL RESILIENCE

By

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ABSTRACT

The Seri indigenous people of Mexico have been living in the desert along the Sea of Cortés for thousands of years. Their territory includes the northern most mixed mangrove estuary in Mexico. After reviewing previous literature about the Seri and the estuary, I developed a set of questions and visited their villages for interviews and a field trip.

The interview topics included how their family groups are defined, what the name was of the group that used to live near the estuary, the status of who is allowed to perform songs and explain traditions, and what environmental changes they have seen at the estuary. Theories about the connection between oral history, oral tradition, and historical events, provided a framework to examine what they told me.

To provide another view of this estuary, I created a Normalized Data Vegetation Index using satellite imagery from the years 2000 to 2018 that provides information about the mangrove vegetation. Instead of only being research subjects, the communities in which anthropologists engage can be considered partners. Since some of the Seri are trained paraecologists, this vegetation index will be presented to them to help in their environmental observations.

I. INTRODUCTION

The people who call themselves the *Comcaac*, also known as the Seri, have lived along the Sea of Cortés in Northwestern Mexico for at least 2,000 years. Within their territory in the Sonoran Desert is a mangrove estuary known as *Estero Sargento*. The Comcaac have intimate relationships with many natural features of their environment, including Estero Sargento. By reviewing previous research about their ties with this estuary, I developed questions to ask the Comcaac during a four-day visit to their villages that included a field trip to the Estero.

According to previous research the Comcaac organized themselves with a system they call *ihiizitim,* which are family groups based on where one is born. One much cited source conflated this definition into a larger structure based upon an outdated theory of territorial patrilineal bands (Moser 1963; see Sheridan 1999, 10 for a critique). Therefore I asked that the Comcaac define the ihiizitim family group in their own words. Other questions included: which family group was associated with Estero Sargento and are there any descendants today? What was the name of that family group? How was the Estero Sargento used in the past and how is it used now? What songs are associated with the Estero Sargento? What changes to its size and condition have my Comcaac consultants observed in their lifetime? What exactly are the numerous overlapping Mexican federal ecological and political designations of Estero Sargento?

Anthropology can engage with the world by providing information to exchange with communities in which research is conducted. This helps close the gap of privilege and education between a researcher and the indigenous people who are the sources. This thesis will be provided to the Comcaac and will include the results of a vegetation index method developed by the Vegetation Index & Phenology (VIP) lab at the University of Arizona (UA), which uses free public satellite data and open source software. Some of the Comcaac are trained as paraecologists, and this information will help inform them about changes to the dimensions and characteristics of Estero Sargento. It will also show them what tools and resources are available

to study environmental change. This thesis contributes to scholarly knowledge about the Comcaac while providing them with satellite vegetation information in return.

(Photo 1: View of Estero Sargento looking from the northern edge in the direction of south. Chris Sauer © 2019)

II. THE COMCAAC AND ESTERO SARGENTO

(MAP 1: Google Maps 2018)

(MAP 2: Google Maps 2018)

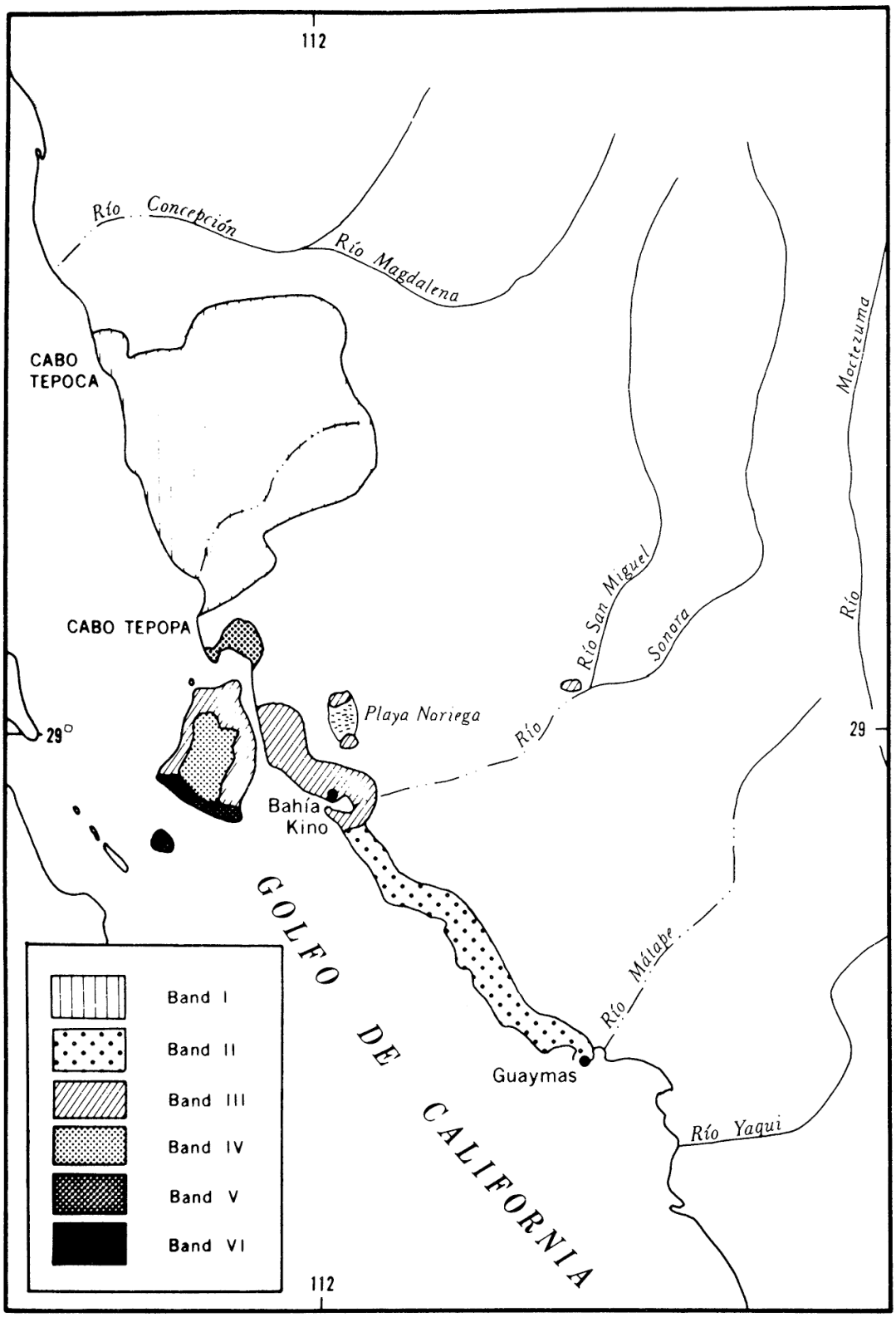
The region the Comcaac call home has been occupied by humans since at least the Paleoindian Period (Bowen 2009; Di Peso 1955:13; Robles and Manzo 1972:201 cited in Martínez-Tagüeña 2015:11). One theory of how they arrived in this area is that instead of travelling inland through the Sonoran Desert they migrated by sea along the Pacific coast where there were animals and plants to eat (Erlandson et al. 2007 cited in Martínez-Tagüeña 2015:12). The oral traditions of the Comcaac themselves suggest that they crossed the Sea of Cortez in reed balsa boats from Baja California using the Midriff Islands, which include their historical homelands of San Esteban Island and Tiburón Island (Sheridan 1999:7).

The Comcaac identify their own historical ancestors as *gigantes* (‘giants’) who play an important mythological role in current Comcaac lives (Felger & Moser 1985:10). Some descriptions of Comcaac from 1692 describe them wearing nose plugs and ear whorls (Di Peso & Matson 1965, 51). In the 18th and 19th centuries they were described having center nose cartilage pierced with a bone decorated with blue green stones and polished pieces of shell (Pfefferkorn 1941, 81 in Bowen 1976, 105). In one of my interviews a Comcaac described the height of a gigante by gesturing to the top of a two story tall salt cedar (Manuel Monroy, interview, December 27, 2018). The Comcaac told me the gigantes engaged in fighting and stealing (Fernando Torres, interview, December 27, 2018). They used magic to protect resources such as fish from use by other gigantes and some of this magic still lingers today (Fernando Torres, interview, December 27, 2018).

The Comcaac speak a language that is for them a thriving first language. Many speak Spanish and some also speak English. Previously, assumptions were made that they were part of various regional language families including Uto-Aztecan, Otomanguean or Yuman, but recent research does not support this (Moser & Marlett 2004, 14). Their isolate language, oral traditions, and archaeological evidence support the idea that the Comcaac have lived in this region of northern Mexico for thousands of years.

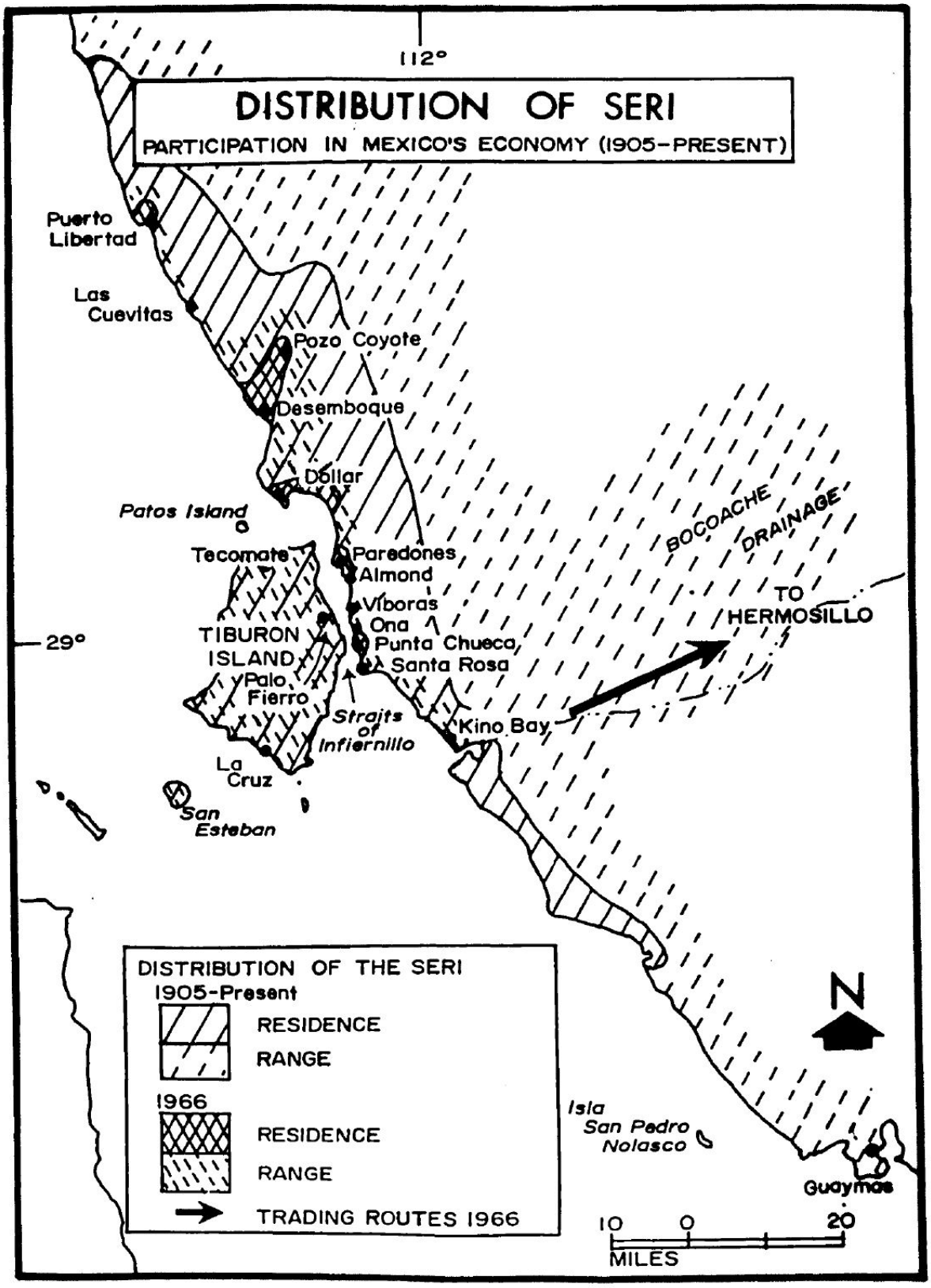
Below is a map that illustrates their territory at the time of contact with the Spanish in the 1600s. Band V encircles the Estero Sargento:

MAP OF THEIR HISTORIC TERRITORY



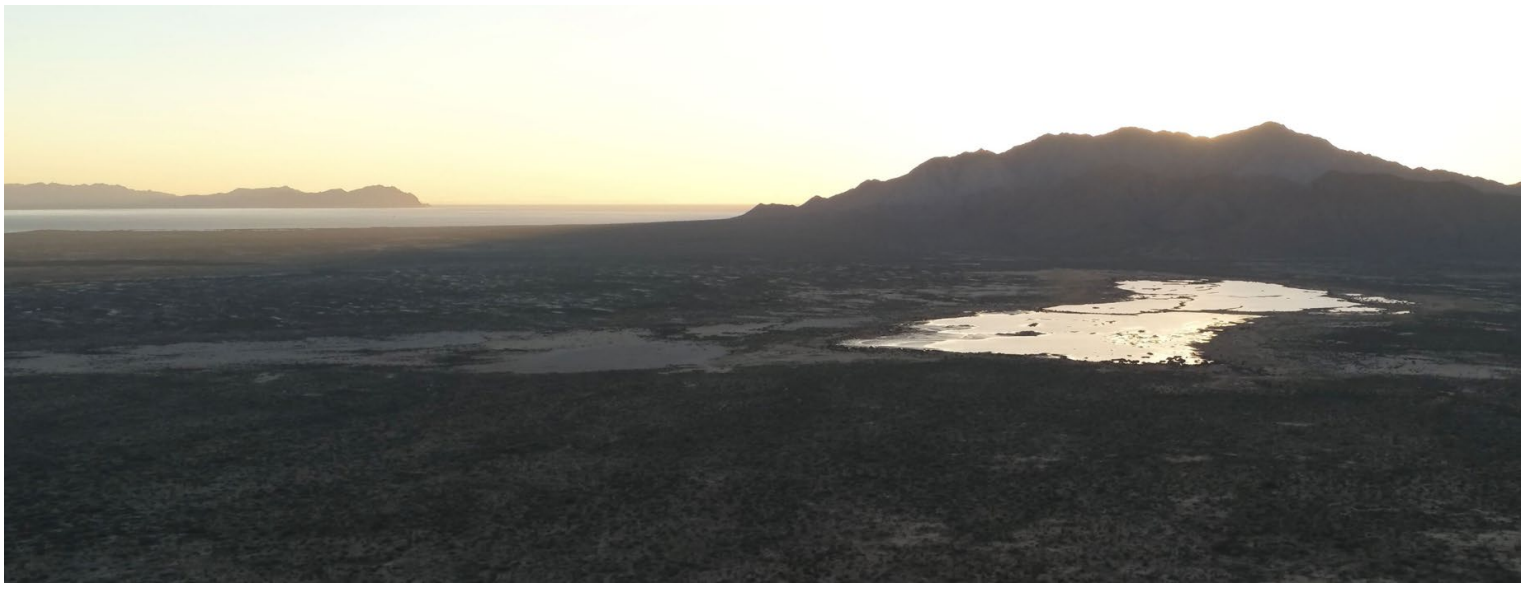
(MAP 3: Bahre 1980, 9)

MAP OF THEIR CURRENT TERRITORY



(MAP 4: Bahre 1967, 94).

The Comcaac do not practice agriculture. Instead they have extensive knowledge of how to gather and hunt plants and animals from both the Sea of Cortés and the desert, along with important knowledge of permanent and seasonal water sources (Felger & Moser 1985). The seasons in the Sonoran Desert are based on temperature and the amount of rainfall, and the Comcaac resided in specific areas depending on changing availability of plants and animals (Felger & Moser 1985). Some of these historic sites are still used today as temporary fishing camps including those adjacent to the Estero Sargento (personal observation, December 2018). Of all the areas with mangroves the heaviest concentration of prehistoric remains are in Estero Sargento (Hills 1973, 25-26). This indicates that the Comcaac lived next to the Estero channels many generations into the past. This long history of settlement in these areas may be explained in part by the fact that there was drinking water in the adjacent *playas* for part of the year (Hills 1973, 29-30).



(Photo 2: View of freshwater playa looking from east to the west, with Estero Sargento on the far left. Chris Sauer © 2019)

Today I have been told the Comcaac number around 800 (Fernando Torres, personal communication, 2017 – 2018). They still live temporarily in seasonal camps depending on the fishing season, but have settled down in the villages of Desemboque de los Seri and Punta Chueca. Some families also live in Bahía de Kino, Puerto Libertad, Hermosillo, and elsewhere in Mexico.

(Photo 3: Fernando Torres. Chris Sauer © 2019)

III. METHOD AND THEORY

Interviewing indigenous people requires an understanding of the context that power and privilege can bring to the process of research. As practicing anthropologists, we need to be aware of the local and global political structures of society, while keeping an eye on the need for social justice (Austin and Quinn 2007). We need to be aware and respect the forms of tradition and permission that guide who it is that can provide this indigenous information, and how best to ask questions and conduct research.

The University of Arizona requires informed consent to do the research like that in this thesis, and has special policies about interviewing indigenous people (Arizona Board of Regents 2016). The UA also has a long history of working with tribes and requires submitting proposals to their Institutional Review Board (IRB) in order to conduct research including interviews. I had to learn about the history of research ethics and how to submit a proposal that would meet IRB guidelines. One of the key points of informed consent in the United States was the way in the U.S. tribes are considered sovereign, and require a government-to-government relationship (Arizona Board of Regents 2016, 1). Many of the procedures followed in the IRB application come from this explicit relationship that dates back to Commerce Clause of the U.S. Constitution.

In contrast, Mexico has a very different foundation on which their relationship with indigenous people is formed. In Mexico, there is a belief that indigenous people are supposed to be integrated into society, in the sense summed up by the phrase "we are all mestizos" (Sheridan 2018). Because tribes are not recognized as sovereign there are no explicit laws about conducting research with them. Instead, a set of guidelines are available from the Comisión Nacional Para el Desarrollo de los Pueblos Indígenas (CDI 2014). These guidelines are an aggregation of a variety of laws including the Mexican constitutional reform in 2001, which recognized "the pluricultural trait of the Mexican Nation, which is originally sustained in their indigenous peoples and communities" (CDI 2014, 14).

In Mexico, generally, oral history and interviews do not require informed consent (Aguila et al 2015, 9). Nevertheless, Mexico does specify another set of guidelines for consulting with indigenous communities (CDI 2014 translation, 5). It is supposed to address the gap of wealth and power between a researcher and an often marginalized Mexican indigenous community (CDI 2014 translation, 14). These suggest procedures and guidelines include respecting their culture

and identity, and that consultation be addressed to their legitimate representatives, respecting their election procedures or customary ways of choosing leaders (CDI 2014 translation, 24).

Because of previous visits to the Comcaac villages, I knew some tribe members who could be my initial point of contact for this permission process. I met Gabriel Hoeffer who knows some English, had worked as a tourist guide, and was also an election observer representative for one of the local political organizations. I asked him to help me determine who and how I could get permission for the interviews. As explained below in the section about Comcaac governance, the tribe has a few avenues of power that only partially overlap. This includes the *ejido* and *comunero* memberships, which are forms of communal landholding in Mexico, but not all Comcaac are members in these organizations (Rentería-Valencia 2015). There are also local fishing cooperatives and representatives consisting of a President and a Council of Elders who are elected every four years (Rentería-Valencia 2015).

Using both the UA IRB and the CDI guidelines I obtained written permission to conduct my interviews from the Comcaac governor and Council of Elders member at the village of Desemboque de los Seri. I then interviewed six people, including Mr. Hoeffer and elders I met previously who have the authority to talk about their culture to outsiders. Mr. Hoeffer identified other interviewees as being knowledgeable about the Estero and who were descendants of the ihiizitm associated with the Estero. During a three day visit in December 2018 a volunteer interpreter and I interviewed Comcaac in the villages of Desemboque de los Seri and Punta Chueca. I explained to them the purpose of my thesis and told them I would pay compensation of either 200 pesos (about $10 US dollars) or the equivalent value of food to interview them for about half an hour. I decided on this compensation after observing the rates they charge for their time during previous visits including with a UA summer class (Wilder 2018). Food was popular because it was either very expensive to buy locally, or expensive to travel over an hour roundtrip to shop in a larger village with more stores and lower prices.

After returning to UA and with the guidance of the Bureau of Applied Research in Anthropology, I processed the interviews. First I identified some topics, or codes, that seemed to overarch the specific interview questions and topics. I defined this code with a topic key word and in a sentence or two. I then collected the interview responses according to these topics. By looking at the interviews this way I could see how, for example, the theme of legitimacy related both to specific examples of permission to use the Estero resources and also to who has permission to perform songs or explain things to outsiders.

Interviewing the Comcaac revealed stories that relate to the interviewees' history, and also stretched back to mythical ancestors who were two stories tall and whose magic remains around the Estero. As such the ideas of Jan Vansina in his influential 1985 book about oral traditions are helpful to find a way to approach this interview material without dismissing everything as abstract and symbolic myth (Vansina 1985). Oral tradition means a story that is passed down through generations, and is both a temporary performance in the moment and a representation of history (Vansina 1985, xi – xii). This is differentiated from oral history, which in contrast implies a story with first-hand knowledge, even if a few generations removed (Vansina 1985).

This is different from the structuralism of Lévi-Straus, which Vansina criticizes because it prevents considering oral traditions as documents of the past. Lévi-Strauss assumed that the myths that are a part of oral traditions are a way for the human mind to communicate hidden messages through structured symbolism (Vansina 1985). This approach does not link the symbolizing of myth to actual human memory (Vansina 1985). Vansina rejects C. Lévi-Strauss' theories of human thought because they were never proven and do not follow scientific procedures (Vansina 1985).

In contrast, Vansina looks at the structuring of oral tradition as reflecting patterns that resulted from the effects of the memorization process, attempts to make the story memorable,

and current priorities that shape what elements of the story should be emphasized (Vansina 1985). In performing stories, there are different mnemonic devices including using objects, landscapes and music (Vansina 1985). This has interesting implications in ethnography since some stories and information might not be revealed unless, for example, while visiting the Estero Sargento with the Comcaac.

Roger Echo-Hawk in his influential 2000 article extended Vansina's ideas and looked specifically at Native American oral traditions as a source of history of the deep past. Tribes such as the Hopi which are now seen as a unified group are actually an amalgamation of different groups that travelled to the mesas and decided to settle in the same villages (Sheridan 2018). Looking specifically at Arikara origin myths, Echo-Hawk says origin myths have some shared narrative elements because at some point the migration patterns of ancestral groups were repeated as various tribes moved and developed into new cultures (Echo-Hawk 2000, 275). Echo-Hawk discusses how some Native American myths relate to memories from the Pleistocene including the darkness of the Arctic Circle, movements through landscapes including giant lakes that have since vanished, and current monumental landmarks that are encoded within various origin myths of tribes (Echo-Hawk 2000, 275-277). With this approach to oral traditions, it becomes possible to find elements of history in myth.

Another element in the thesis resulted from a summer abroad class in 2018 when I brought some satellite photos of the Estero Sargento that were printed on large format paper. We visited the Estero with some Comcaac friends and they were very interested in the photos. I knew that the UA used remote sensing to create vegetation indexes to measure the health of plants. This information was of interest to the Comcaac so I created an index to evaluate the direction and extent of changes to the size and health of the Estero Sargento.

Remote sensing is based on the premise that that the earth's landscapes can be characterized on the basis of their reflectance and emission of light (Liverman 1998, 39). Repeat

satellite photos add a temporal dimension which meant for the first time that repeated time series analysis was available to scientists without having to fly special planes for specific projects. This also means there are opportunities to look at social science issues related to land cover and land use, and changes to the environment from the effects of human activity (Liverman 1998, 52).

By relating human behavior including socioeconomic models, local culture, economic and social classes and field based ethnography to remote sensing information, a process of "socializing the pixel" looks to model and predict environmental changes (Liverman 1998, 100-112). Instead of the remote sensing being purely an application to measure what and how much is changing, "socializing the pixel" adds the dimension of "why" to remote sensing (Liverman 1998, 100 – 112).

The UA has been working for many years for NASA in developing sophisticated vegetation indices. This is a method of extracting useful data from satellite photos that can systematically track the changes in health for areas of vegetation. Part of the technique involves developing and understanding visual signatures of certain types of vegetation. At the UA Dr. Kamel Didan was part of a study of mangroves in Indonesia and measured the impact of human activity on a mangrove estuary (Rahman et al. 2012, 98-99).

Under the guidance of the VIP lab at the UA I acquired no cost repeat satellite sensor data going back to 1983. With the computer program Python, I created a vegetation index to track the size of the mangrove, and using information from pixels as a proxy for the health of mangrove plants I calculated changes in the condition of the mangrove. This vegetation index will be the focus of the results I will share with the Comcaac.

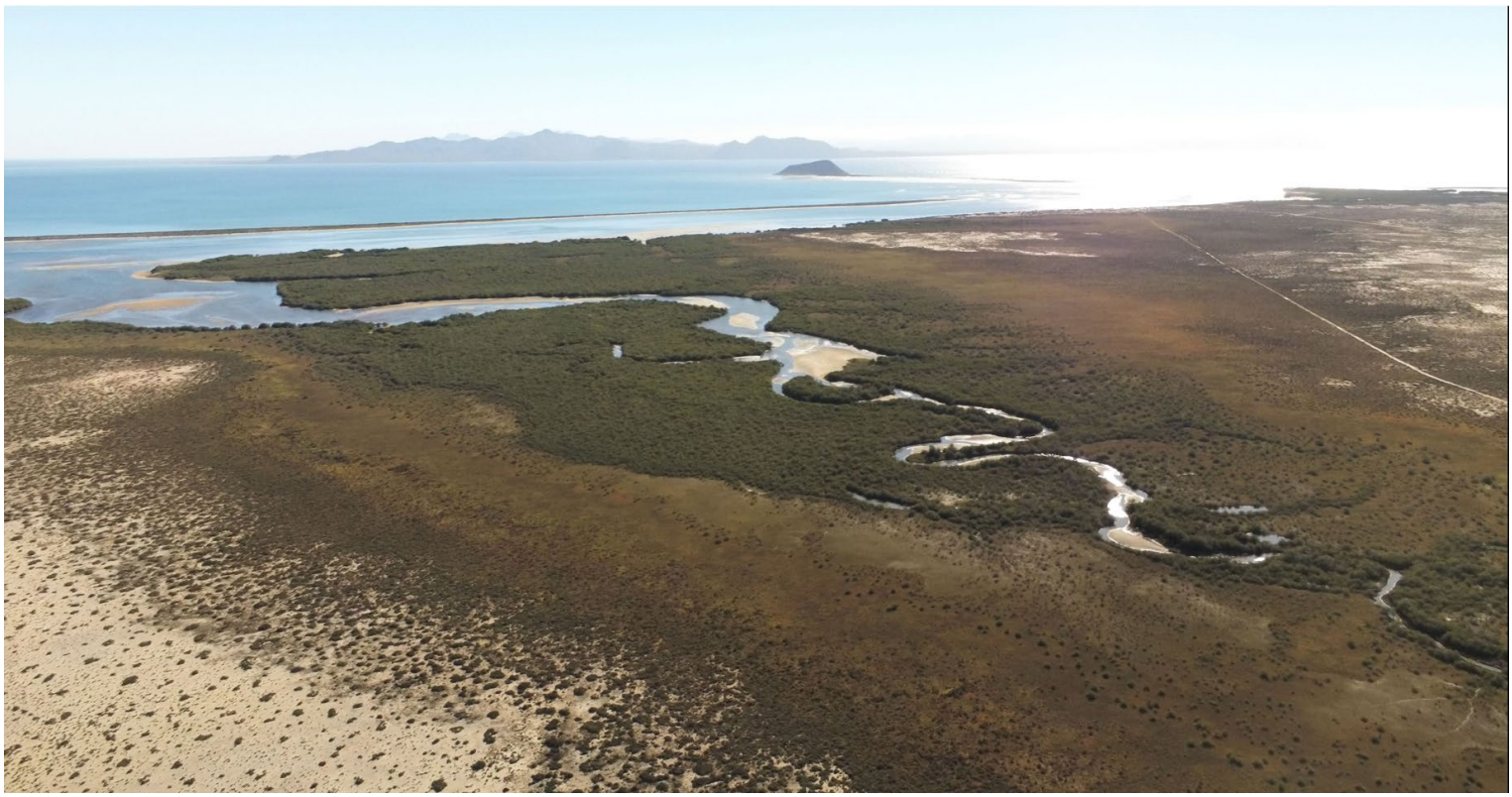
IV. MANGROVE ESTUARY ECOLOGY

The Comcaac are fortunate to live in one of the most beautiful, extreme, and interesting environments in the world. When one hears the word desert the image that comes to mind does not match the quantity of plants and other life found in the Sonoran Desert thanks to its long

summer monsoon rainy season, and a shorter season of rain in the winter. The Comcaac villages and the Estero Sargento are located adjacent to the coast of the Sea of Cortez. The Sea was formed as the Baja California peninsula moved to the west over the last six million years, rifting from the mainland along the San Andreas Fault (Sala 2001). This rifting, along with volcanic uprisings and rising sea levels, formed the Midriff Islands in the middle of the Sea (Dolby et al 2015). These islands provide protection and breeding grounds for unique birds and animals (Dolby et al 2015).

The variation in summer and winter water current rotation stirs the Sea with cool, deep and nutrient rich water (Wilder 2018). This provides a nutrient rich supply of water that mixes with the warmer surface water and helps create chlorophyll and then plankton, which provide a base for the bottom of the extensive food chain of fish and predators (Wilder 2018). In addition, the Sea has one of the highest variation between heights of high tide and low tide in the world (Wilder 2018).

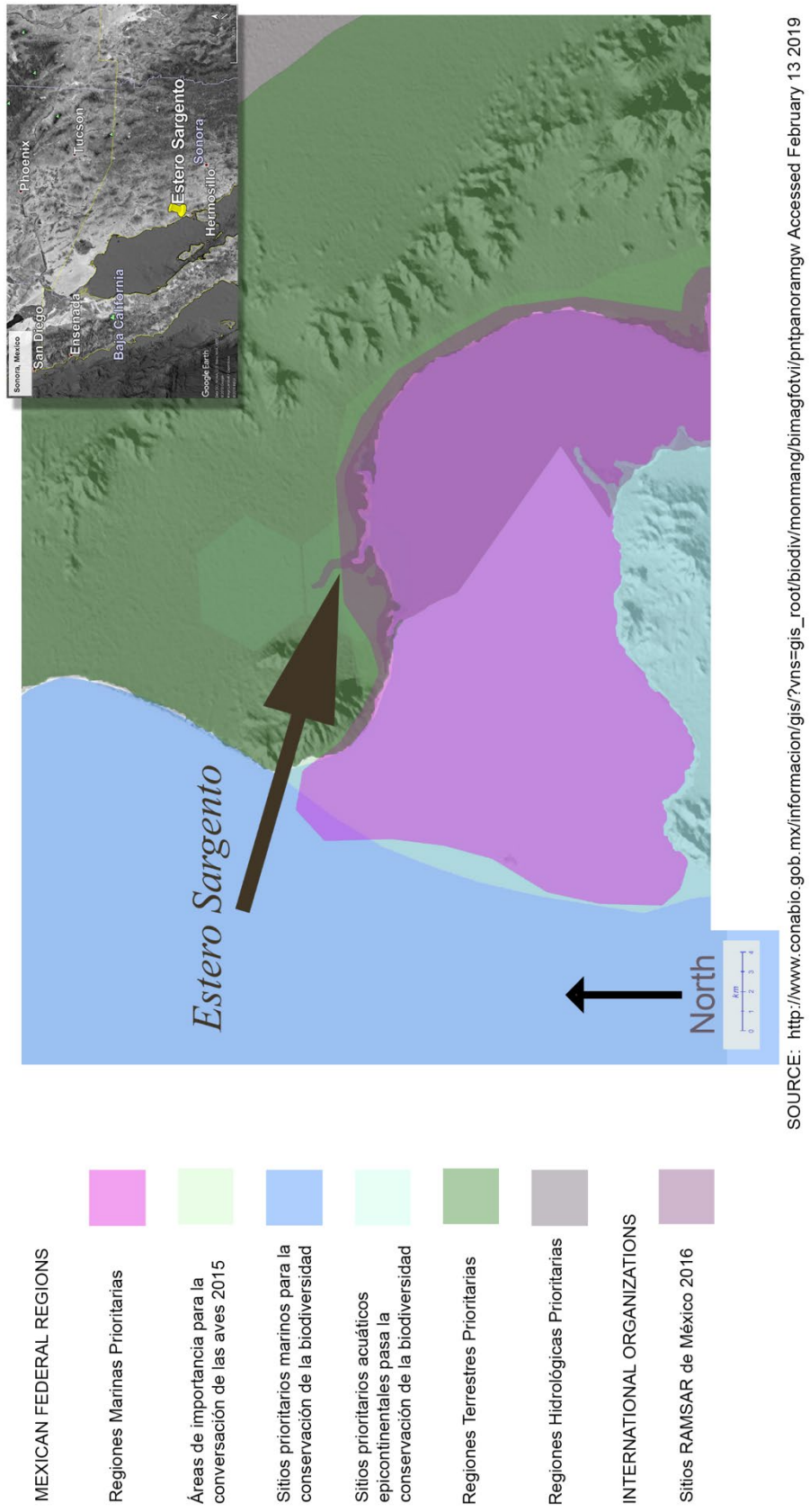
As a result of how it was formed and these water currents, the Sea of Cortés and its islands and shores have a high level of biodiversity including endemic species levels of 54% for reptiles and 30% for plants (Dolby et al 2015). This level of biodiversity places Mexico in the list of the top ten megadiverse nations (Silva et al 2014, 3). These unique species include the endangered *vaquita* (small porpoise) and the *totoaba* fish. The Sea is also home to turtles, whales, sharks, sealions, seabirds, mollusks, and seawater vegetation (Sala 2001). There are over 5,000 invertebrate species, and 1,115 vertebrate species including 31 species of whales and dolphins that represent 37% of the world's species (Wilder 2018).



(Photo 4: View of Estero Sargento looking from the eastern edge in the direction of west towards the Sea of Cortés on the right, Tiburón Island straight ahead, and *Infiernillo Canal* to the left. Chris Sauer © 2019)

(MAP 5: Estero Sargento, 15.8km^2 in size. Google Maps 2018).

The Estero Sargento mangrove estuary is adjacent to a channel between Tiburón Island and the mainland. This channel, called the Infiernillo, is designated as a high biodiversity area by the Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), the Mexican federal organization that promotes and protects biodiversity (Arriaga et al 1998, 38). The Estero Sargento lies within at least six overlapping Mexican federal environmental protected areas, as well as an internationally recognized wetlands area, as illustrated in the map below.



SOURCE: http://www.conabio.gob.mx/informacion/gis/?vns=gis_root/biodiv/monmang/bimagfotvi/pntpanoramgw Accessed February 13 2019

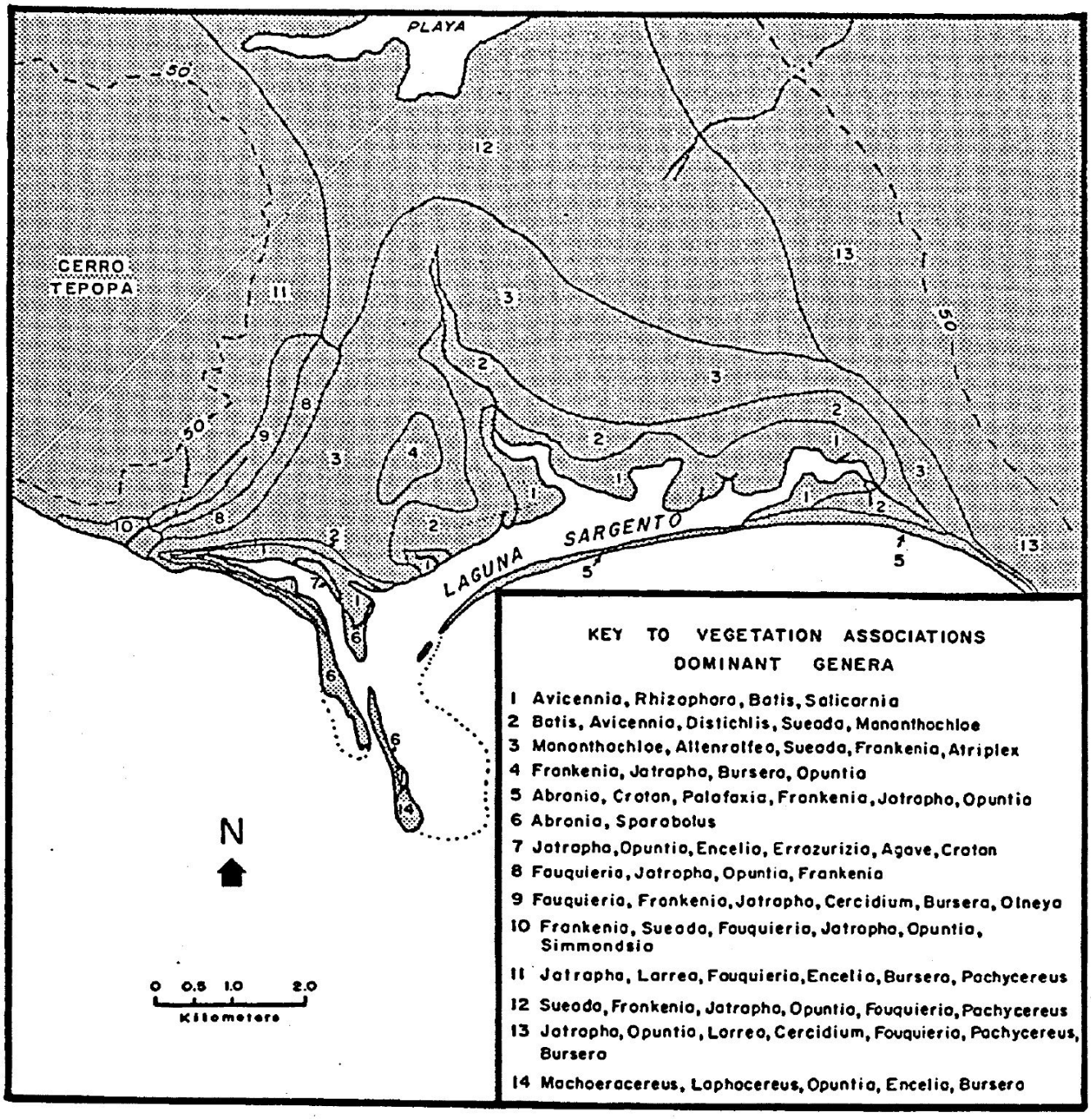
(Map 6: By Chris Sauer, Data Source CONABIO 2018)

CONABIO made these designations because it is an area for breeding migratory birds (López-Medellín et al 2009, 14), there is economic activity of artisanal fishing by the Comcaac (Arriaga et al 1998, 77), and it is adjacent to a region that contains a high level of endemism of mammals and reptiles (Felger et al 2013, 3). The designation of high biodiversity includes both the marine system and also coastal aquatic ecosystems that together form an ecological system (Arriaga et al 1998, 31).

Within Mexico, the Estero Sargento is unique because it is the northernmost reach of a mix of different species of mangroves. One of the best descriptions of the importance of mangroves is found in an article about costal erosion in Latin America:

> "Mangroves, wetlands and dunes are examples of ecosystems of strategic importance in Latin America. Mangroves are tightly regulated by ecohydrodynamical processes, which involve interactions and feedback between terrestrial, estuarine, coastal, and offshore areas" (Wolanski, 2006 quoted in Silva et al 2014). Mangroves evolve via intertwining nonlinear interactions between biological, chemical, and physical factors, each of which has particular temporal and spatial scales. To understand the mangrove ecosystem as a whole, and to preserve it and ensure that human activity does not disrupt it, interdisciplinary studies should be undertaken. Two examples of the importance of mangrove ecosystems is its function of as a natural sink for atmospheric CO2 (Ayukai, 1998 quoted in Silva et al 2014), and as coastal protection. Mazda et al. (2007 quoted in Silva et al 2014) explain the function of wetlands and mangroves, pointing out that there is a nonlinear relationship between wave attenuation and the size of wetland and mangrove ecosystems, which means that even small wetlands afford substantial protection from waves." (Silva et al 2014, 6).

Mangroves exist in a unique natural environment including high annual temperature, warm water, little fresh water addition and some level of hypersalinity (Sherwin 1971, 27). They originated in the mid-Cretaceous in the Indo-Malaysian area (Sherwin 1971, 24).



(MAP 7: Sherwin 1971, 36)

Mangroves trees are unique in that they are adapted to live in saltwater (Riegner 2001). Usually the associated estuaries have inflows of freshwater, but in this region there are no freshwater inflows and they are negative estuaries where salinity increases farther from the shore heading inland (Riegner 2001). The adjacent rain water-fed freshwater playa might be a mitigating factor to the Estero Sargento but this has not been studied (Riegner 2001). They are limited in their northward expansion because they are very susceptible to damage from frost (Riegner 2001).

The Estero is dominated by a species of red mangrove (*Rhizophora mangle,* family Rhizophoraceae) which has a high tolerance to salt and is identified by its stilt roots adjacent to the ocean (Riegner 2001, 73-82). It excludes salt within its root-cell membranes (Riegner 2001, 73-82). The black mangrove (*Avicennia germinans,* family Avicenniaceae) is on higher ground that the high tide reaches only occasionally (Moser 1973, 4). It excretes salt from its leaves (Riegner 2001, 73-82). The while mangrove (*Laguncularia racemose,* family Combretaceae) is farthest from the shore (Riegner 2001, 73-82). Plants, animals birds and intertidal invertebrates thrive within this protected Estero area (Riegner 2001, 73-82). Besides fishing and gathering food, the Estero is also a source of material for the Comcaac to make necklaces, along with dye for their basketry (Felger and Moser 1985, 359).

PARTIAL LIST OF ESTERO SARGENTO SPECIES

	Common Name	Scientific Name	Description	Notes
Plants				
	Red Mangrove	*Rhizophora mangle,* family Rhizophoraceae	Closest to Sea. High tolerance to salt and is found with its distinctive stilt roots adjacent to the ocean. It uses a process of salt exclusion in its root-cell membranes.	Comcaac uses include making a necklace from the fruit, making a dye for their basketry, eating the fruit, and as a medicine to be taken at the onset of dysentery, along with treating diabetes. (Felger and Moser 1985, 359).
	Black mangrove	*Avicennia germinans* , family Avicenniaceae	It is only occasionally washed with the high tide. It uses a process of salt secretion.	(Riegner 2001, 73-82)
	White mangrove	*Laguncularia racemose* , family Combretaceae	Farthest from the water.	(Riegner 2001, 73-82)
	Saltwort	*Batis maritima*		(Moser 1973, 10)
	Glasswort	*Salicornia europaea,* family Amaranthaceae	Submerged in up to four feet of water at high tide.	(Moser 1973, 3)
	Glasswort	*Salicornia pacifica*		(Moser 1973, 11)
	Alkaliweed	*Cressa truxillensis*	Adjacent to tide and on higher desert fringe.	(Moser 1973, 11)
	Seashore dropseed	*Sporabolus virginicus*	Within the Estero and on higher desert fringe.	(Moser 1973, 12)
	Alkali heath	*Frankenia grandifolia*	On the outer limits of the Estero.	(Moser 1973, 12)
Animals				(Riegner 2001, 73-82)
	Barnacles			(Riegner 2001, 73-82)
	Mangrove oyster	*Ostrea columbiensis*	Collected off the roots of red mangrove.	(Felger & Moser 1985, 24)
	Mullet	*Mugil* spp		(Felger & Moser 1985, 24)
	Crabs	*Callinectes bellicosus, Uca princeps, Eurytium affine*	Swimmin crab, blue crab, fiddler crab.	(Felger & Moser 1985, 38), (Moser 1973, 31)
	Clams	*Chione fluctifraga, Chione californiensis*		(Moser 1973, 34)
	Algae			(Riegner 2001, 73-82)
	Snails	*Nassarius molestus, Cerithidia, Conus, Natica, Turritella*		(Riegner 2001, 73-82), (Moser 1973, 34)
	Mussels			(Riegner 2001, 73-82)
	Sponges			(Riegner 2001, 73-82)
	Colonial tunicates			(Riegner 2001, 73-82)
	Shrimp	*Callianassa* sp, *Palaemon* sp, suborder Gammaridae.	Ghost shrimp, other shrimp.	(Moser 1973, 32-33)
	Worms	*Arenicola glasselli, Marphysa*	Burrowing worm.	(Moser 1973, 33-35)
Reptiles				
	Common green turtle	*Chelonia mydas*	The most common of many different turtle species, often in the Infiernillo Canal adjacent to Estero Sargento.	(Felger & Moser 1985, 43)
Insects				
	Ant	*Crematogaster sp*		(Moser 1973, 5)
	Gnat	*Culicoides sureus*	Biting gnat in the summer.	(Felger & Moser 1985, 24)
	Mangrove spider	*Gasterocantha elipsoides*	Very colorful.	(Felger & Moser 1985, 38)
	Spiders	*Cyclosa* sp, *Argiope argentat, Metepeira* sp		(Felger & Moser 1985, 27), (Moser 1973, 27)
	Flies		Dragonflies, flies.	(Moser 1973, 28)
Juvenile Species				
	Yellow snapper	*Lutjanus argentiventris*		(Riegner 2001, 73-82)
	Stripped mullet	*Mugil cephalus*		(Riegner 2001, 73-82)
	Flagfin mojarra	*Eucinostomas* spp		(Riegner 2001, 73-82)
	Sting ray	*Urolophus helleri*		(Riegner 2001, 73-82)
	Guaymas goby	*Quietula guaymasiae*		(Riegner 2001, 73-82)
	Jaiba crab		Breeding ground.	(Bourillon-Moreno 2002, 232)
Birds			27 species identified.	(Moser 1973, 21)
	Herring gull.			(Moser 1973, 24)
	Eagle		Possible sighting of bald eagle.	(Moser 1973, 25)
	White-winged dove			(Moser 1973, 21)
	Virginia rail			(Moser 1973, 21)
	Herons, egrets	family Ardeidae	Snowy egrets. Louisiana heron. Great blue heron.	(Riegner 2001, 73-82), (Moser 1973, 22)
	Ibises	family Threskiornithidae	White ibis.	(Riegner 2001, 73-82), (Moser 1973, 23)
	Shorebirds	order Charadriiformes	Curlew, whimbrel, willet, marbled godwit, black billed plover, royal tern, american avocets,	(Riegner 2001, 73-82), (Moser 1973, 24)
	Osprey	*Pandion haliaetus* , family Pandionidae		(Riegner 2001, 73-82)
	Ducks			(Moser 1973, 23)
	Mangrove warbler	*Dendroica petechia rhizophorae* , family Parulidae		(Riegner 2001, 73-82)

V. COMCAAC HISTORY AND RECENT MEXICAN FEDERAL LAND DESIGNATIONS IN THEIR TERRITORY

The Comcaac are identified in Spanish historical documents going back to the 1600s (Sheridan 1999, 9). At various times the Comcaac battled the Spanish and later Mexicans in different partnerships and enmities with other indigenous tribes. By the early 1900s, after a protracted war with a local rancher, their population had dwindled, and by 1941 a visit to their home base on Tiburón Island counted only 160 (Sheridan 1999, 461-462). At times the Mexican government has taken an interest in the Comcaac, and in 1938 they were organized into a fishing cooperative that was the beginning of their village of Desemboque de los Seri and later Punta Chueca (Sheridan 1999, 462).

Beginning in the 1960s, the Comcaac have had a complicated history regarding their possession of land and sea in this area, which is important in understanding the Estero Sargento. In 1963 Tiburón Island was declared a nature and wildlife refuge in response to concerns about the overhunting of mule deer on the mainland by poachers (Bourillón-Moreno 2002, 51-53). The island was intended to be a protected area that would allow mule deer to thrive (Bourillón-Moreno 2002, 51-53). Despite the historic Comcaac use of the island, permanent habitation and visits were forbidden (Bourillón-Moreno 2002, 51-53). In 1967 a federal Marine base was built on the island that is still in operation (Bourillón-Moreno 2002, 51-53). In 1970 as a result of populist policies of President Luis Echeverría the Comcaac were granted rights over the part of the mainland coast they have long occupied, creating the ejido of Desemboque de los Seris and an annex to the south known as Punta Chueca (Bourillón-Moreno 2002, 51-53).

In Mexico the ejido is a form of federally chartered corporate community, defined as “an organization of peasant households that controls certain basic natural resources, and that preserves its corporate identity through time” (Sheridan 1996, xxiii). The majority of these corporate communities are the ejidos which may be recently formed as the result of processes the

Mexican government implemented following the Constitution of 1917 (Sheridan 1996, xxiii). A smaller number of corporate communities, including part of the Comcaac territory, are *comunidades*, a designation that highlights that the community predated the Revolution of 1910, and while not explicit, implies that it is an indigenous community (Kelly et al 2010, 164). This is very different compared to tribes in the United States, which have sovereign status and reservations (Sheridan 2018).

Because of concerns about overfishing and the endangerment of juvenile shrimp, in 1974 the Infiernillo Canal became a fishing reserve by presidential order (Bourillón-Moreno 2002, 51-52). In 1975 all of Tiburón Island was added to the ejido by presidential order, creating a total of 212,078 hectares of communally owned land (Bourillón-Moreno 2002, 53). That same year, bighorn sheep were introduced to the island and it became a game reserve in 1978 (Bourillón-Moreno 2002, 54). In 1975 another Seri Fishing Cooperative was established that included their exclusive right to fish in the Infiernillo Canal (Bourillón-Moreno 2002, 56). In 2005 the Gulf of California and its islands were recognized internationally and were granted World Heritage status by UNESCO (Felger, Romero-Morales, and Wilder 2013, 21-22).

As a result of neoliberal initiatives in the 1990s the federal government began a program of wildlife management within protected areas to generate revenue for the benefit of local communities that allowed the Comcaac to sell big horn sheep hunting permits (Weber et al 2006, 1480). Unfortunately when the Mexican government created these protected areas, they did not provide support or funds to manage them. The Comcaac therefore have to be the stewards and co-managers while also navigating within their own complicated society and conforming to the regulations created by the Mexican government (Bourillón-Moreno 2002, 56). They have had mixed success with this. The hunting initiative has been taken over by local Mexican business people but the Comcaac do control and administer their fishing coop (Rentería-Valencia 2015, 56). These sorts of dynamics will continue, and therefore it is critical that the Comcaac

complement their traditional ecological knowledge of their natural resources with a knowledge of modern ecological principles and management techniques.

VI. COMCAAC SOCIAL ORGANIZATION AND GOVERNANCE

The way the Comcaac have organized themselves now is a reflection of their history. In the past the different Comcaac groups did not have centralized leadership. Except in times of war, they didn't have leaders at all (Rentería-Valencia 2015, 109). At this time they have at least three centers of power; ejido and comunidad membership voting privileges, fishing coop membership, and a system of elected representatives. According to conversations with Fernando Torres in 2017 - 2018 they have elections every four years and elect a president and a set of governors along with members of the Council of Elders. This allows for representation for those not in the comunidad, ejido or fishing coop (Rentería-Valencia 2015, 48). The president is allowed to sign off on official designations and permissions related to tribal membership (personal observation, 2017). These various sources of power create a situation where promises have to be made across alliances and between the two villages (personal observation, 2018). It appears that factions group together and elect a set of leaders in exchange for rewards including automobiles and money (personal observation, 2018).

Without historical centralized leadership, their family dynamics were complicated and included more than sixty different terms for siblings and extended family, along with obligations to share food and other resources, as well as restrictions on who could talk to each other (Felger & Moser 1985, 5-6). Social gatherings currently include four-day fiestas to celebrate puberty or the capture of a leatherback turtle, and at times larger ceremonies would involve people from many groups (Felger & Moser 1985, 6). They have a large New Year's celebration on June 1st, which corresponds generally to the start of the summer monsoon rains that bring new growth to the Sonoran Desert, including allowing the harvesting of mesquite pods and cactus fruit (personal observation, 2016-2018).

Understanding the concept of their family groups called ihiizitim is therefore important. There were a number of definitions of the term ihiizitim in previous literature on the Comcaac. Generally, it has been described as a place where you were born and where your placenta was buried. As a result you are connected to the land and an extended family of ancestors (Sheridan 1999, 12). Because some of the literature cited the same Moser article from 1963, I decided to include in my interviews a question asking Comcaac to define the term for me.

What the Comcaac told me about the ihiizitim ranged from specific definitions of how someone is a member of a particular group to general descriptions of what the ihiizitim meant to them. Besides confirming that it is the place of birth and where one's placenta is buried (Humberto Romero Morales, interview, December 29, 2018), it was also identified by Fernando Torres as meaning the family of someone's grandmother who passed away at 120 years old (Fernando Torres, interview, December 27, 2018). One description was it is the place where all the people live (Maria Dolores Cubillas Torres, interview, December 27, 2018). Instead of being only where you were born and your placenta buried, others told me it was where your ancestors were born and that the land belongs to you (Francisco Gabriel Hoeffer, interview, December 27, 2018). One interviewee specified that besides being born and having ones placenta buried there, someone has to live there for seven to ten years (Humberto Romero Morales, interview, December 29, 2018).

These descriptions do not conflict with the Moser 1963 article. The section in the article that describes that the Comcaac can choose either their mother or their father's ihiizitim might relate to the way the Comcaac described to me their different ideas of what ihiizitim means to them personally and emotionally (Moser 1963, 26). Instead of looking for a specific definition, all of the Comcaac interview statements overlap and reflect the complicated meaning of what an ihiizitim is.

One important contrast with the 1963 Moser article is that Moser identifies the group around the Estero Sargento as Band V (see map 4 above) and says that there are no descendants because they either left or were exterminated (Moser 1963, 25). However, about 20 miles away from Estero Sargento in Desemboque de los Seri I interviewed Manuel Monroy and Saul Gabriel Molmar who said they are descendants, and some interviewees told me they knew other descendants in the Comcaac villages.

An important topic that developed from the interviews was about the name of the band that lived at Estero Sargento. In contrast with previous research, the Comcaac told me that the name of the group around Estero Sargento was the *Tepocas.* This is different than Spanish documents going back to the 1700s that identified the group around the Estero as *Salineros,* a band that at that time consisted of 44 families (Martínez-Tagüeña 2015, 99). In addition, the Tepocas were specified in the Spanish documents as a group located farther to the north (Sheridan 1999, 19). Nevertheless, one of the Estero Sargento ihiizitim members along with another Comcaac, identified this Estero group as Tepocas (Humberto Romero Molmar, interview, December 29, 2018), (Manuel Monroy, interview, December 27, 2018). They explained that Tepocas came from the Guaymas area (Humberto Romero Morales, interview, December 29, 2018). In explaining how they got to that area, Humberto Romero Morales said the Tepocas came there after the gigantes were there, and had moved to Estero Sargento after they lived near Guaymas along a river (Humberto Romero Morales, interview, December 29, 2018).

One of the characteristics of this Estero Sargento family group is that "they had a different accent, there are two pronunciations of this word 'shakam' (ʃakɑm) and with the Estero Sargento accent it is 'shishkamm' (ʃɪʃkɑm)" (Fernando Torres, interview, December 27, 2018). This is probably the Comcaac word for fish; zixcám (Moser & Marlett 2010, 634). Manuel

Monroy says they mixed with other groups and spoke not just a different accent but a different language, as did those from Tiburón Island (Manuel Monroy, interview, December 27, 2018).

The difference between what was reported to me about the name of the group as compared to 17th century documents can be explained a few ways. One is that by the 1920s the Comcaac had dwindled to only a couple of hundred survivors living on Tiburón Island. It could be that in the last period of the 19th century the Comcaac merged a few groups and the Salineros were absorbed into the Tepocas. Another is that the boundary of the Tepoca range itself was at Estero Sargento.

This difference in names about the Estero Sargento band also relates to Vansina's ideas about the contrast between oral tradition and oral history (Vansina 1985, 3-13). For example in the following story Manuel Monroy specifies that he heard it from his family who heard it from family members that were there. He said it took place before his grandmother was alive, and we narrowed down what year that could mean. This would be a part of oral history relating first-hand knowledge, but Manuel's story is at its farthest edge where mystical powers also come into effect. In contrast, calling Estero Sargento bands Tepocas instead of Salineros might reflect the process of oral tradition where current priorities have changed what elements of a story should be emphasized. In this example, the history of the bands might now be simplified. The Comcaac say they were Tepocas when in fact the actual history was perhaps more complicated, i.e. that they formed from a mixture of bands or some other reason. This speculation enables us to engage with these stories as a source of some historical information, instead of dismissing the stories entirely as myths.

The story Manuel Monroy told me illustrates a connection between him and the Estero Sargento ihiizitim and he said this story took place approximately 150 years ago. He said *bandidos* were coming to attack the Comcaac. We discussed what the word bandidos described and Manual said they were armed, organized Mexicans, but not necessarily soldiers. He said,

"the Mexicans in that time were bad people." As they were coming to attack, a Comcaac boy started to sing a song and three or four minutes later a fog came. The Comcaac hid and were able to escape (Manuel Monroy, interview, December 27, 2018).

Echo-Hawk talked about applying rules of evidence to oral history and tradition (Echo-Hawk 2000, 268). In this example we can turn to historical records that show various campaigns against the Comcaac that generally correlate to the period Monroy described. The most specific reference dates from 1844 when the "Sonora governor sent Captain Victor Araiza to the coast opposite Tiburón for the purpose of rounding up hostile Seri and punishing them" (Spicer 1962, 112). Later another force was sent to take the Seris prisoner "organized under the command of Colonel Andrade by land and Captain Spence by sea." Another campaign was in 1880 (Spicer 1962, 112 - 113). In the late 1800s there were further battles with the local rancher Pascual Encinas, who established his ranch headquarters at Siete Cerros on the outskirts of Seri territory (Sheridan 1999). This shows a connection between oral history and historical written records.

As further support for a connection between current Comcaac and the Estero Sargento ihiizitim*,* the 1963 Moser article mentions the custom of naming a dog after a geographical feature in one's ihiizitim *(*Moser 1963, 26). Manuel Monroy, one of the descendants from the Estero Sargento ihiizitim, told me that his very unusual looking dog is named after a channel within the Estero Sargento (Manuel Monroy, interview, December 27, 2018).

At the time of my visit, members of Gabriel Hoeffer's family were camping adjacent to the Estero in a seasonal fishing camp located about 300 feet from a channel and known as *Zaaj Cheel* (O'Meara 2010, 24). In that sense, the Estero Sargento is being used by these descendants now.

(Photo 5: View of family fishing camp at Estero Sargento, with Manuel Monroy on the right. Chris Sauer © 2019)

VII. COMCAAC USE OF ESTERO SARGENTO AND THREATS TO ITS INTEGRITY

The Comcaac have lived for centuries in a region where most people would be lucky to survive a few days. With the relationship they have with their environment, which includes their extensive knowledge of sources of food, drinking water, and the seasons of rain, asking them specifically about Estero Sargento provides details about their culture that might not be revealed with more general topical inquiries. In a sense I wanted to know their culture through the lens of the Estero. As such, I asked them about the history of their uses of the Estero Sargento.

Interviewees told me about where people lived in the Estero Sargento area. One area was in a camp called Campo Dólar, which is to the north of Estero Sargento and also near rain fed seasonal playas (Maria Dolores Cubillas Torres, interview, December 27, 2018). This camp was known by the Comcaac as *Hast Quipac* and approximately 16 people lived there in March 1951

(Martínez-Tagüeña 2015, 99). People would live near the fish within the Estero and the Sea of Cortés and construct houses out of large mangrove branches (Fernando Torres, interview, December 27, 2018). Fernando Torres said that when there was a lot of wind they would fish with a harpoon in the Estero Sargento because it would be too windy in the Infiernillo Canal. They would gather *jaibas* (crabs) (Fernando Torres, interview, December 27, 2018). They would fish for species the Comcaac called *lissa* and *corvina* in the channels with spears because it was so shallow (Humberto Romero Morales, interview, December 29, 2018) (Saul Gabriel Molmar, interview, December 28, 2018). A few interviewees mentioned hunting turtles in the past. They would also hunt deer, and gather pitaya fruit and make mesquite flour (Manuel Monroy, interview, December 27, 2018). They would gather honey from bees (Saul Gabriel Molmar, interview, December 28, 2018).

Saul Gabriel Molmar told me about that there was no drinking water near, except when it rained and made "pools". In other research, Comcaac collected water from indentations in rocks called *tinajas,* but the term "pools" might refer to the rainfed playas near Estero Sargento (Moser and Felger 1985, 34). When there was no water around the Estero Sargento, they would bring water from the permanent spring on Tiburón Island, and also at times live on Tiburón (Saul Gabriel Molmar, interview, December 28, 2018). They used to carry water from *Sierra Peineta*, located to the south of the Estero on the Sonoran mainland, and known by the Comcaac name *haast eemla* (Francisco Gabriel Hoeffer, interview, December 27, 2018).

They would fish in Estero Sargento if it was the right season, but if there were no fish they would walk north to Puerto Libertad or Puerto Lobos (Manuel Monroy, interview, December 27, 2018). This range northern range is the territory for which the Tepocas were known to live according to some historical records (Bahre 1967, 44-46. Sheridan 1999, 9-10). This lends some credence to the idea that the Estero Sargento was the southernmost location for the Tepocas, and that the Salineros started directly to the south. The Moser 1963 article refers to

a group that lived north of Estero Sargento as "Tepoca or Salinero" so my interviews raise more questions than answers (Moser 1963, 14). As far as what happened to them, Humberto Morales told me this Estero Sargento group left the area when "governors" (Sonoran I assume) and ranchers tried to exterminate them (Humberto Romero Morales, interview, December 29, 2018).

As a result of asking questions specific to Estero Sargento, I was told a story about the lissa fish that live in the channels. This fish is easily caught during low tide. The Comcaac told me that the original owners of Estero Sargento were gigantes. Every channel and entrance had a name (Manuel Monroy, interview, December 27, 2018), (Humberto Romero Morales, interview, December 29, 2018). The gigantes started fighting and stealing and many people would rob other people's fish (Manuel Monroy, interview, December 27, 2018). The gigantes protected the lissa because they liked it the most (Francisco Gabriel Hoeffer, interview, December 27, 2018). In the past they used to form a special protection around Estero Sargento so other gigantes wouldn't go there (Francisco Gabriel Hoeffer, interview, December 27, 2018). Even today you can't eat the fish that belonged to the gigantes because it is cursed by magic (Francisco Gabriel Hoeffer, interview, December 27, 2018). Because the magic is still there when they go visit Estero Sargento they go with a lot of respect (Francisco Gabriel Hoeffer, interview, December 27, 2018).

The Comcaac said that if my interpreter and I were to eat the Estero Sargento fish before 5p or 6p, we will have special nightmares called *yaaxapotoil* (Francisco Gabriel Hoeffer, interview, December 27, 2018). You will be unable to awake, and start seeing visions, and it will feel like you are being eaten or hit by something (Manuel Monroy, interview, December 27, 2018). Saul Molnar's grandfather told him that people would see many warriors with spears, and bows and arrows, but really no one was there (Saul Gabriel Molmar, interview, December 28, 2018).

When we went to the Estero Sargento with Manuel and Gabriel, Manuel told me that he is allowed to eat the fish because he is a descendant of that family group. Fernando Torres, whose family come from Tiburón Island, told me he also has permission to eat the fish. Of my six interviewees, Manuel, Humberto, Gabriel's family, and Fernando told me they were allowed to eat the fish.

In the interviews I asked the Comcaac about songs specific to Estero Sargento. While there are hundreds of songs, and Fernando Torres for instance knows 600, there are not many specifically for mangrove estuaries but they are included in other songs. The Comcaac told me they have songs for fish, to lure fish, for birds, a special bird called the "wowo café", lobsters, the sea, the wind, prayer songs, war songs, fiesta songs, coming of age songs, songs for natural power, and songs for the ironwood tree (Humberto Romero Morales, interview, December 29, 2018), (Maria Dolores Cubillas Torres, interview, December 27, 2018), (Manuel Monroy, interview, December 27, 2018), (Saul Gabriel Molmar, interview, December 28, 2018).

The selection of songs depends on the location, the mood, what a person is doing, and what animals they see. When we visited Estero Sargento with Manuel and Gabriel, Manuel sang a song that a fish in the channel sings when it is about to be eaten by a bird.

(Photo 6. Manuel Monroy singing at tide pool. Chris Sauer © 2019.)

People learn songs from their family. Not everyone knows the same songs, and only some people are authorized to perform or explain the songs to outsiders. As you get older, you keep learning new songs, but Saul mentioned that his nine year old niece knows a song he didn't know.

The Comcaac told me how the Estero is used now. When there is a lot of wind in the Infiernillo Canal they go to the Estero to rest (Fernando Torres, interview, December 27, 2018), (Humberto Romero Morales, interview, December 29, 2018), (Saul Gabriel Molmar, interview, December 28, 2018). When there is no food elsewhere, they can go to the Estero at low tide when the fish is trapped in tide pools and get them by hand (Fernando Torres, interview, December 27, 2018), (Francisco Gabriel Hoeffer, interview, December 27, 2018). When we visited Estero Sargento with Manuel Monroy and Gabriel Hoeffer, we saw schools of fish in the

low tide estero channel bottoms. The fish were about two inches long. I estimated a school of fish trapped in one tidepool had approximately 100 fish within an area four feet square.

(Photo 7: Lissa fish in a tide pool. Chris Sauer © 2019.)

They also gather large and small octopuses, and shells to make necklaces (Maria Dolores Cubillas Torres, interview, December 27, 2018). The red mangrove is used to treat diabetes (Francisco Gabriel Hoeffer, interview, December 27, 2018).

In the interviews I asked for descriptions of what environmental changes people have personally observed in Estero Sargento. Fernando told me it is growing in new areas where, when he was little, there were no mangroves. He said 30 years ago you could walk through areas that you now need a machete to get through. There are more fish, plants and mangroves (Fernando Torres, interview, December 27, 2018). Fernando said one reason for the increase in mangroves is because they used to cut them to make their houses, but now they don't do that anymore. When Saul Molnar lived there 55 years ago they saw only small mangroves, and also

now there are many less land animals such as bighorn sheep and deer because the game is depleted.

Humberto Morales talked in detail about the water rising and killing the mangroves (Humberto Romero Morales, interview, December 29, 2018). He said changes in water levels, rainfall, and hurricanes are deforming the beach and threatening it's integrity (Humberto Romero Morales, interview, December 29, 2018). This has changed the area near Campo Dólar by 30 to 100 meters (Humberto Romero Morales, interview, December 29, 2018). The water and wind will change the beaches more (Humberto Romero Morales, interview, December 29, 2018). Humberto is a plant expert and had a detailed perspective on coastline changes.

The Comcaac face ongoing threats to their territory as the Sonoran Desert continues to be seen as a resource for mining as well as commercial farming dependent solely on aquifer irrigation. During a UA study abroad field trip to the region during the summer of 2018 the Comcaac described an example of one threat. A mining company convinced a Comcaac tribal member to sign off on a mining permit even though this individual did not have that type of authority. Another Comcaac member upon discovering this, enlisted the help of a Mexico City Non-Governmental Organization to fight this unauthorized permission. While attempting to resolve this infringement on their sovereignty, the mining company said they would not conduct any activities. However when the Comcaac went for a site inspection on their own, they saw that the company had placed mining equipment on their territory and determined that the company was currently doing exploratory digging. With help from their newfound NGO partners they managed to expel this operation (Chris Sauer personal communication, June 2018). This example shows the need for the Comcaac to have as much help as possible in order to protect themselves from further attempts at developing their natural resources without authorization. The more they know about Estero Sargento including satellite imagery of its condition and an understanding of any developing changes from global warming, the better. Other recent development initiatives in

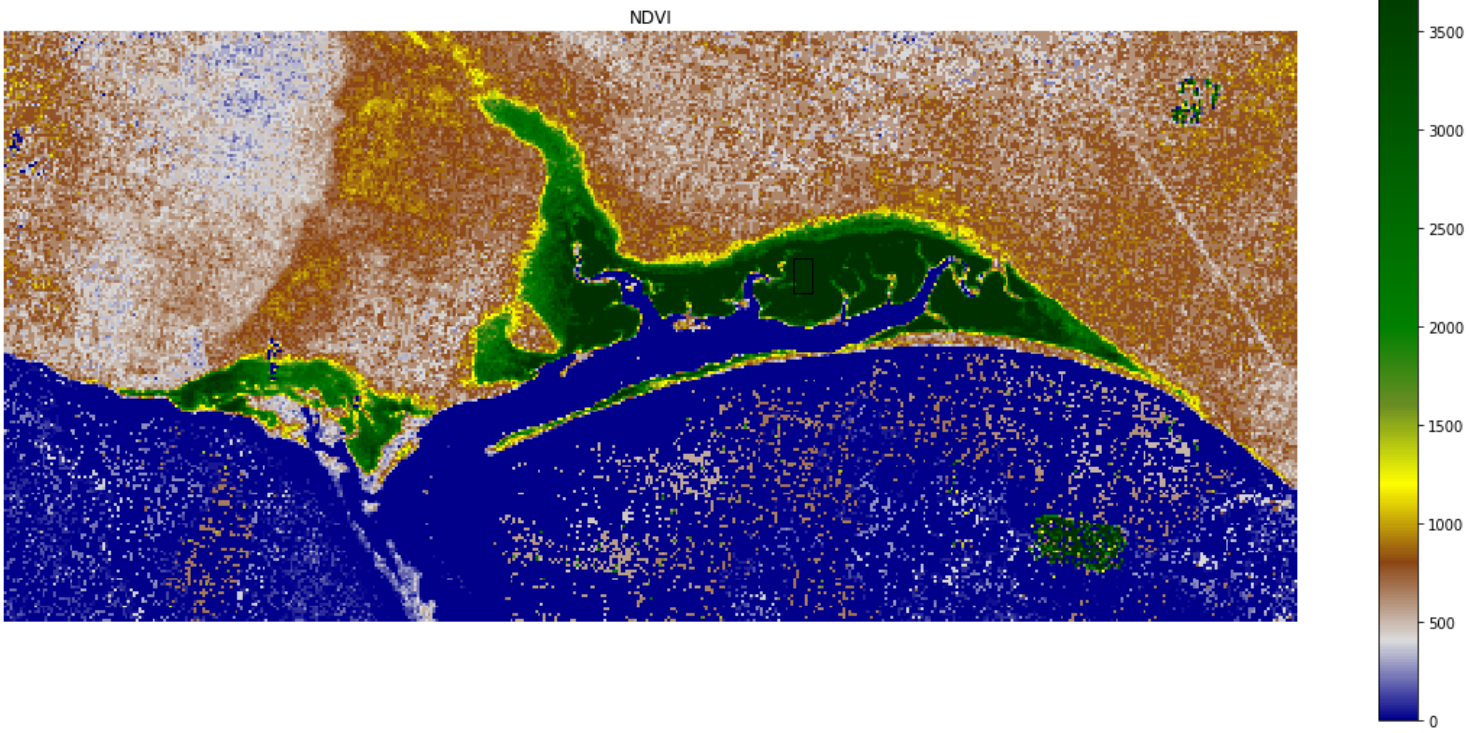
Estero Sargento include seawater farming and a shrimp farm (Felger, Romero-Morales, and Wilder 2013, 23).

VIII. NORMALIZED DIFFERENCE VEGETATION INDEX

I developed a normalized difference vegetation index (NDVI) of Estero Sargento. This is a way to measure surface reflectance information from satellite photos as a proxy for the health of vegetation, including phenology and changes to land cover (Rahman et al, 2013, 98). This information will be provided to the Comcaac not only to show them the actual results of the NDVI but also to make them aware of the kind of information is available to them about their environment. They might develop other types of questions that this NDVI can help answer, and this information exchange is part of a relationship building process.

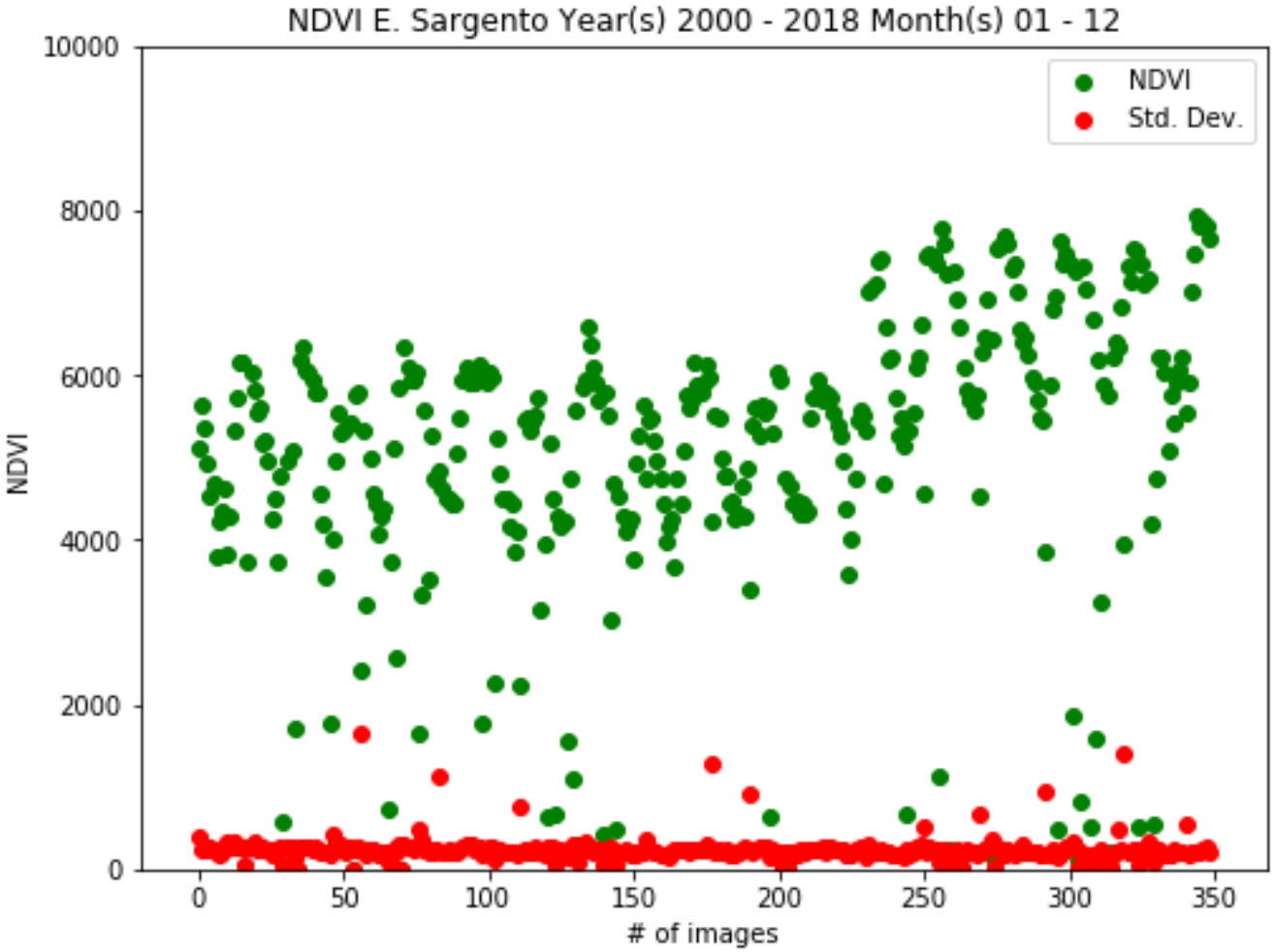
The process to create the NDVI was to find LANDSAT satellite data from two different satellites that have crossed Estero Sargento about twice a month from 2000 to 2018. With help from the VIP lab at the UA, we preprocessed the data to create an NDVI that I could then analyze using the Python computer programming language. Here is an image of an average of all the NDVI data. The highest values, colored green, correlate to the most vegetation:

Here is an image of an average of all the NDVI data. The highest values, colored green, correlate to the most vegetation:



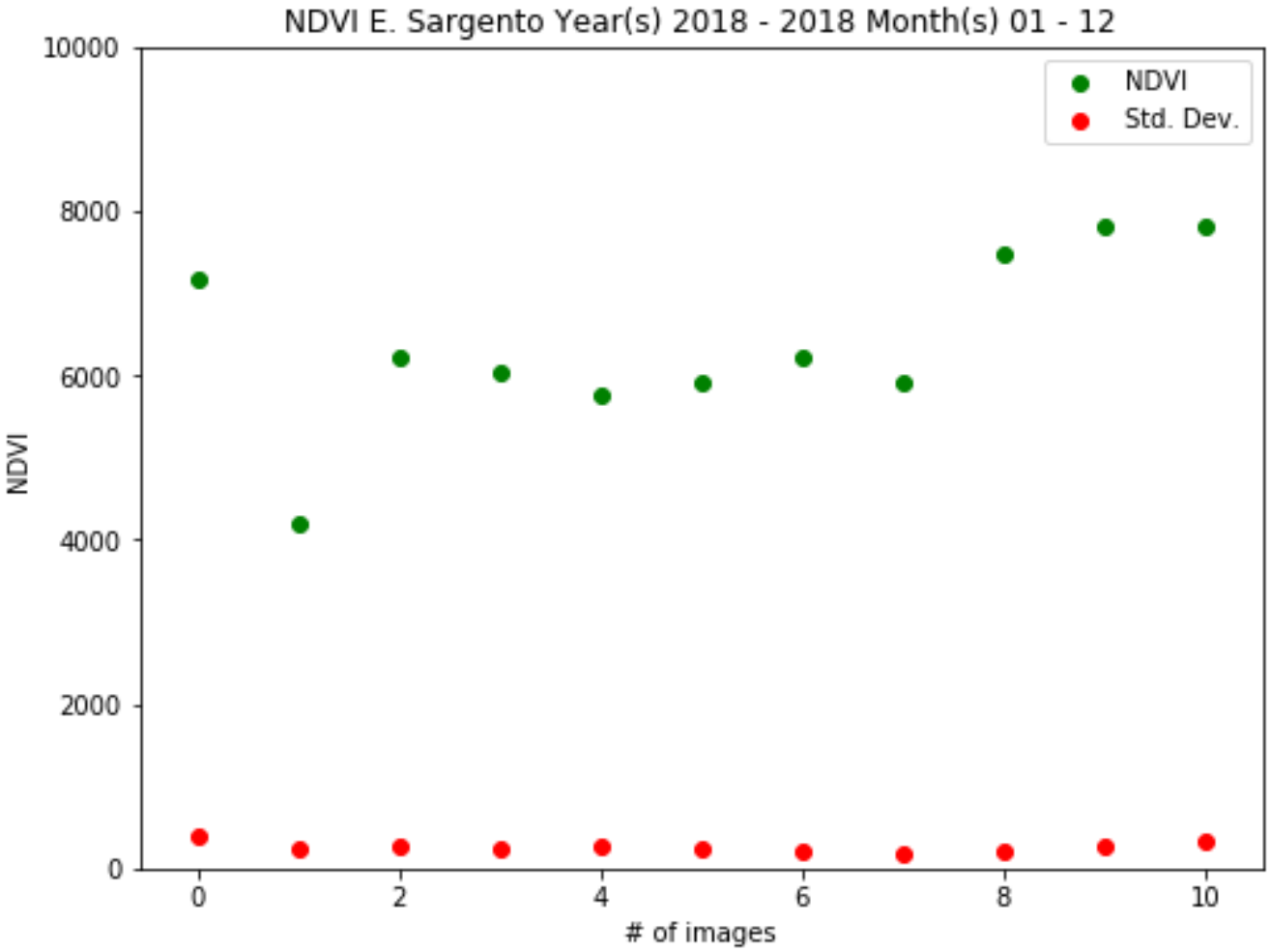
(CHART 1: Average of all NDVI values at Estero Sargento 2000 – 2018. By Chris Sauer at the University of Arizona Vegetation Index & Phenology Lab. Data source: LP DAAC 2019.)

Using Python I developed a way to look at a region approximately 360 square meters in a mangrove dense area of Estero Sargento. From this I made a chart of each value over the entire time period:



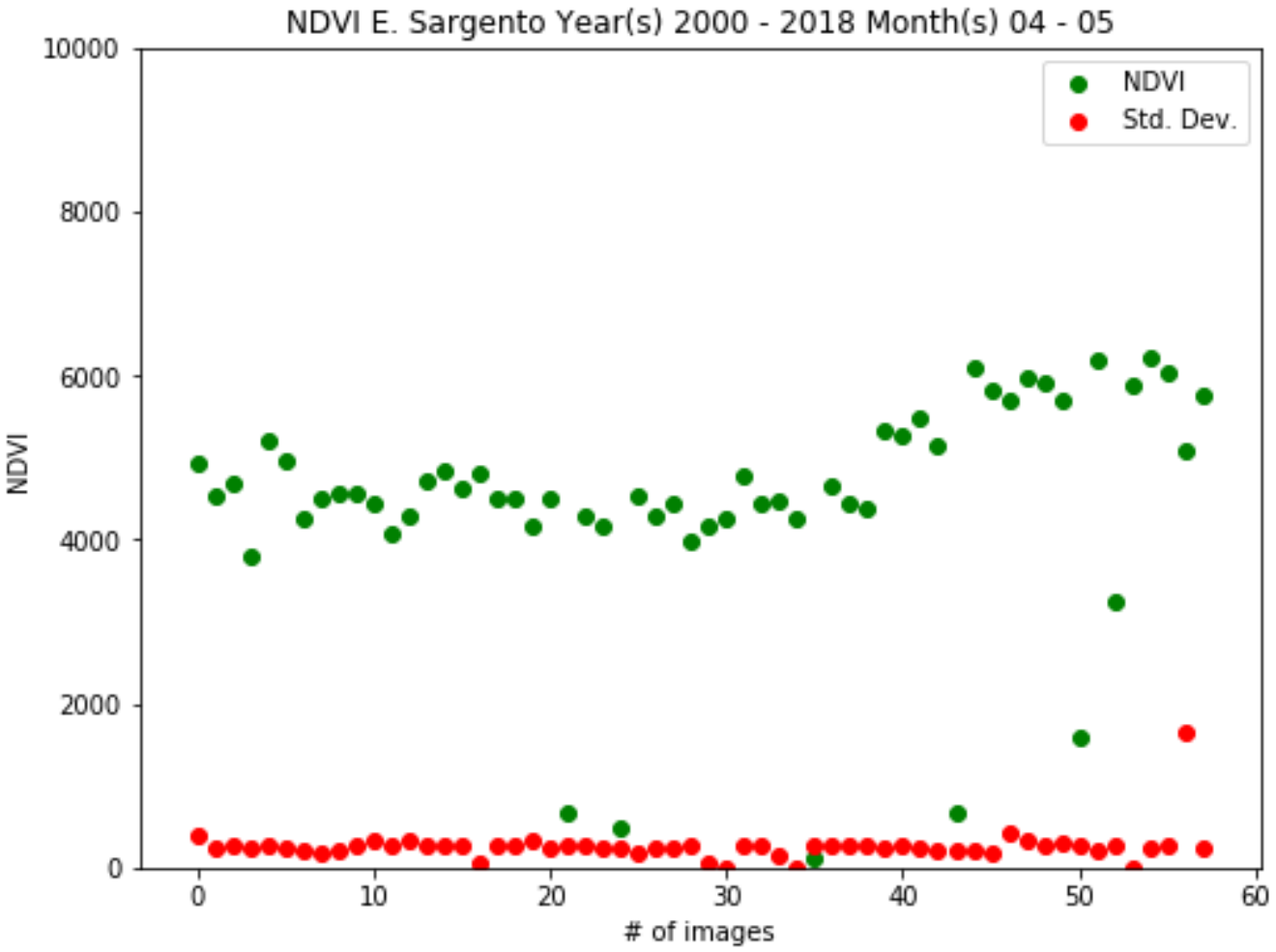
(CHART 2: NDVI numerical values focused on mangroves at Estero Sargento 2000 – 2018. By Chris Sauer at the University of Arizona Vegetation Index & Phenology Lab. Data source: LP DAAC 2019.)

This chart focuses on all months in the year 2018:



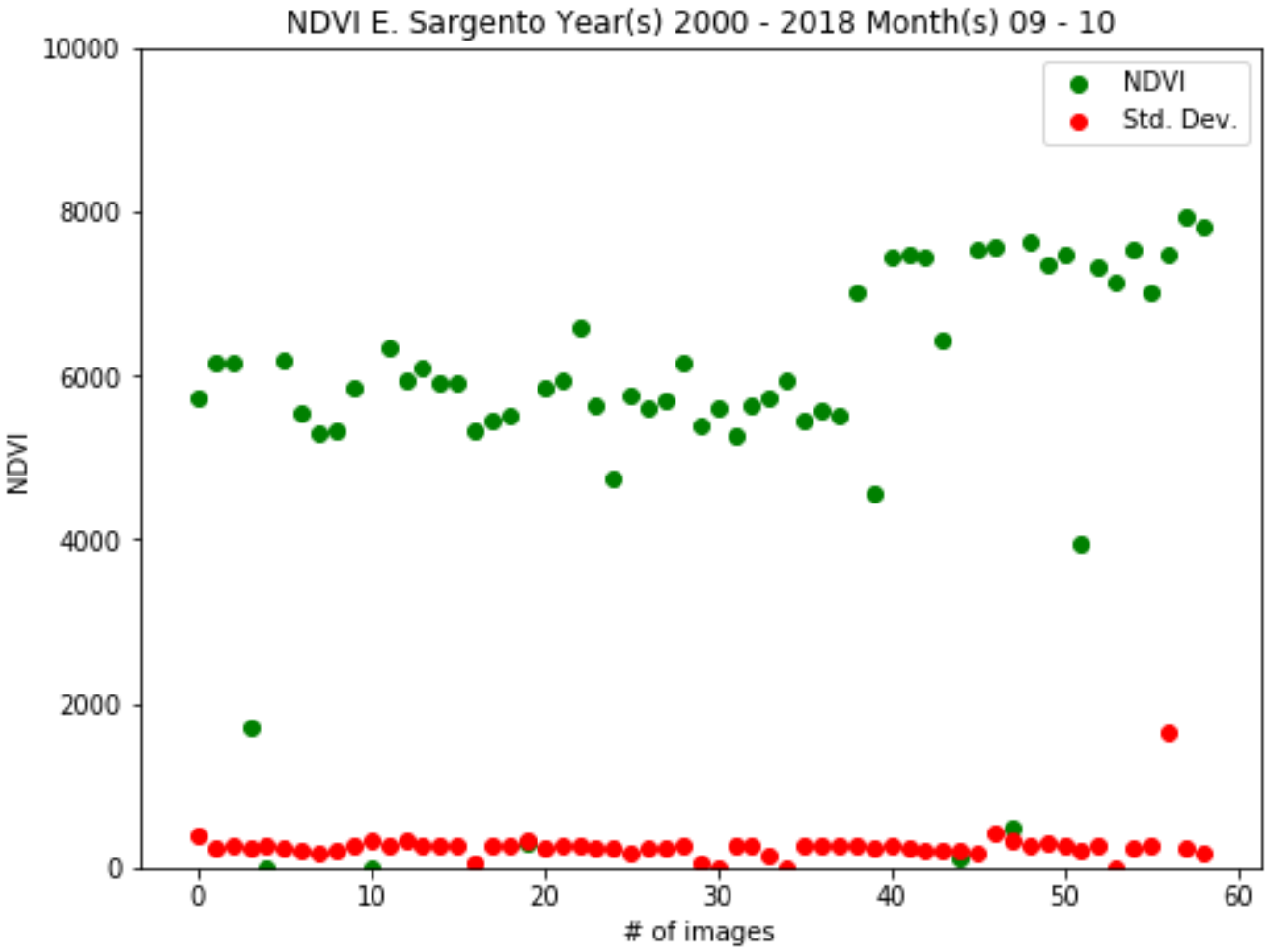
(CHART 3: NDVI numerical values for 2018 focused on mangroves. By Chris Sauer at the University of Arizona Vegetation Index & Phenology Lab. Data source: LP DAAC 2019.)

These are the two driest months over 18 years:



(CHART 4: NDVI numerical values for 18 years, April and May, focused on mangroves. By Chris Sauer at the University of Arizona Vegetation Index & Phenology Lab. Data source: LP DAAC 2019.)

Then compare this to the two months with the most vegetation:



(CHART 5: NDVI numerical values for September – October focused on mangroves at Estero Sargento 2000 – 2018. By Chris Sauer at the University of Arizona Vegetation Index & Phenology Lab. Data source: LP DAAC 2019.)

With further analysis, we can calculate the seasonal growth cycle or phenology, as well as analyze anomalies and compare them to weather events such as hurricanes, along with changes in sea levels, water temperature and other environmental changes. Other impacts on this Estero Sargento environment could include the increase in large scale commercial agriculture adjacent to the Comcaac territory.

IX. CONCLUSIONS

When reviewing previous research about the Comcaac, Estero Sargento would often be mentioned in passing while focusing on general topics such as hunting, fishing cooperatives, plant surveys and transects, songs, archaeological investigations and historical camps. By focusing on Estero Sargento, an interesting perspective on the band names as well as what an ihiizitim is, was discovered. In addition in my literature review I did not encounter the story of the fog hiding Comcaac in Estero Sargento or the story of the cursed fish.

These interviews hint at how Comcaac oral history and tradition can point towards deep history. While the band that lived around Estero Sargento according to some research and Spanish documents were known as Salineros, my interviewees said they were the Tepocas. Further research might include detailed interviews about the history of Estero groups. It would be productive to conduct a survey of both villages to ask who lived at the Estero Sargento and what was their name. With more information about the name of the group that lived at Estero Sargento, the theories of Vansina and Echo-Hawk might shed some light by combining sources of evidence such as Comcaac stories, historical written documents and archeological research.

The Comcaac have an ongoing relationship with the two story people known as gigantes that preceded them in Estero Sargento. The gigantes fought and stole fish from each other, and then left magic on Estero fish that still impacts the Comcaac today. Further questions include; how do they know what happens when the fish is eaten without permission, have they seen this happen? Are people encompassed in the old magic or do they somehow belong to a land in a similar way as the gigantes? Do they belong to the same ihiizitim as the gigantes? It would be interesting to understand the rules of the magic that lets some Comcaac eat the fish while other people suffer from such specific nightmares that they have a name for them; yaaxapotoil. Such a study could include analyzing the lissa for toxins or other effects.

Another interesting topic from these interviews is the way in which knowing songs, traditional knowledge, and the ability to eat special fish are ways of demonstrating hierarchical status. Gabriel Hoeffer told me he is not allowed to perform songs and knows three of them. Fernando is allowed to demonstrate traditional knowledge and songs but Fernando's grandmother knows even more songs. Not everyone knows the same songs, and even a nine year old might know a song someone in their 70s doesn't. How does this performance and knowledge status relate to their family power structure and dynamic, especially considering their previous lack of central leadership?

On a previous visit I observed that some Comcaac are trained as para-ecologists, and they prepare environmental reports for the Mexican government by personally visiting certain locations in their territory. The satellite data used in the NDVI is available for free from a United States Geological Service website, and was processed using free open source software. Using this information it would be possible for the Comcaac to measure environmental change over an area of hundreds of kilometers.

From this satellite data, the VIP lab at the U of A has developed data analysis signals that can identify drastic recent changes that result from human activity such as changing the land cover from one type to another. Other uses could be for measuring large long term changes to the coastline and the impact of recent extreme weather such as hurricanes. This satellite data observation could be a part of their ongoing environmental observation and provide them tools to track large scale changes to their territory.

When I interviewed Humberto Romero, he was able to specifically delineate sections of the coast line that has changed at Estero Sargento. He also told me about changes in the distribution of certain plants at the coast. Using Cathy Moser's 1973 undergraduate thesis that consists of a series of transects through the Estero, it would be interesting to visit these areas with Humberto and revisit the transects. The VIP lab is working on using simple drones to

enable similar transects but in a faster and more efficient way. At an eight hour drive from Tucson Arizona, Estero Sargento can be the location of U of A student projects that can help quantify these environmental changes the Comcaac have told me they observe.

Desemboque de los Seri and Estero Sargento are fascinating areas and the Comcaac I have referenced are accessible and have hosted visits and many conversations with anthropologists and other researchers over the years. Hopefully this undergraduate research thesis can point other students to these very interesting people in Sonora state, Mexico.

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